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# HMC288MS8

## 2 dB LSB GaAs MMIC 3-BIT DIGITAL ATTENUATOR, 0.7 - 3.7 GHz



### Typical Applications

The HMC288MS8 is ideal for:

- Cellular
- PCS, ISM, MMDS
- WLL applications

### Features

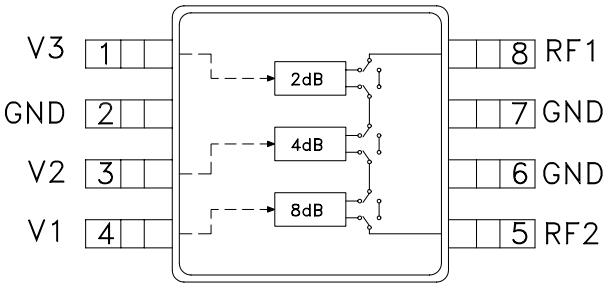
2 dB LSB Steps to 14 dB

Single Positive Control Per BIT

Monotonic: ±03 dB Bit Error Typical

Miniature MSOP-8 Package, 14.8mm²

### Functional Diagram




### General Description

The HMC288MS8 is a broadband 3-bit positive control GaAs IC digital attenuator in an 8 lead MSOP surface mount plastic package. Covering 0.7 to 3.7 GHz, the insertion loss is typically less than 1.2 to 1.8 dB. The attenuator bit values are 2 (LSB), 4, and 8 dB for a total attenuation of 14 dB. Accuracy is excellent at ± 0.3 dB typical with an IIP3 of up to +51 dBm. Three bit control voltage inputs, toggled between 0 and +3 to +5V, are used to select each attenuation state at less than 50 uA each. A single Vdd bias of +3 to +5V applied through an external 5K Ohm resistor is required while occupying less than 14.8 mm².

### Electrical Specifications, $T_A$ = +25° C, Vdd = +3V to +5V & Vctl = 0/Vdd (Unless Otherwise Stated)

| Parameter | | Frequency | Min. | Typical | Max. | Units |
|---|---|---|---|---|---|---|
| Insertion Loss | | 0.7 - 1.4 GHz<br>1.4 - 2.3 GHz<br>2.3 - 2.7 GHz<br>2.7 - 3.7 GHz | | 1.0<br>1.3<br>1.5<br>1.7 | 1.4<br>1.7<br>2.0<br>2.3 | dB<br>dB<br>dB<br>dB |
| Attenuation Range | | 0.7 - 3.7 GHz | | 14 | | dB |
| Return Loss (RF1 & RF2, All Atten. States) | | 0.7 - 1.4 GHz<br>1.4 - 2.3 GHz<br>2.3 - 2.7 GHz<br>2.7 - 3.7 GHz | 14<br>11<br>10<br>9 | 17<br>15<br>14<br>12 | | dB<br>dB<br>dB<br>dB |
| Attenuation Accuracy: (Referenced to Insertion Loss) | | | | | | |
| All Attenuation States<br>All Attenuation States<br>All Attenuation States<br>All Attenuation States | | 0.7 - 1.4 GHz<br>1.4 - 2.3 GHz<br>2.3 - 2.7 GHz<br>2.7 - 3.7 GHz | ± 0.3 + 3% of Atten. Setting Max<br>± 0.2 + 3% of Atten. Setting Max<br>± 0.3 + 3% of Atten. Setting Max<br>± 0.3 + 4% of Atten. Setting Max | | | dB<br>dB<br>dB<br>dB |
| Input Power for 0.1 dB Compression | 5V<br>3V | 0.7 - 3.7 GHz | | 25<br>22 | | dBm<br>dBm |
| Input Third Order Intercept Point<br>(Two-tone Input Power = 0dBm Each Tone) | 5V<br>3V | 0.7 - 3.7 GHz | | 51<br>47 | | dBm<br>dBm |
| Switching Characteristics | | 0.7 - 3.7 GHz | | | | |
| tRISE, tFALL (10/90% RF)<br>tON, tOFF (50% CTL to 10/90% RF) | | | | 560<br>600 | | ns<br>ns |

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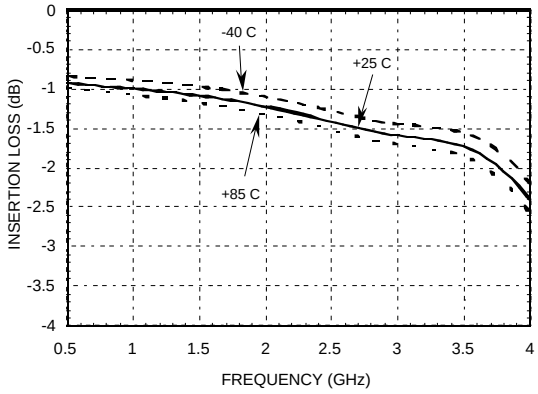
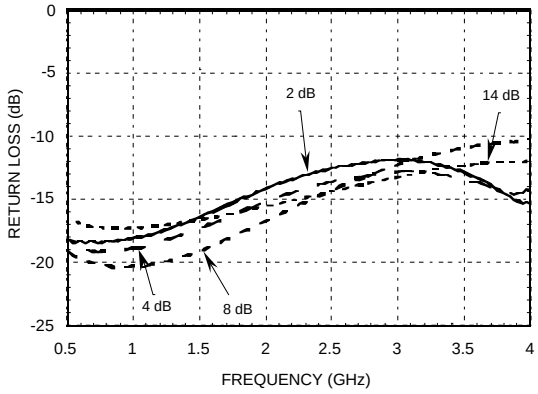
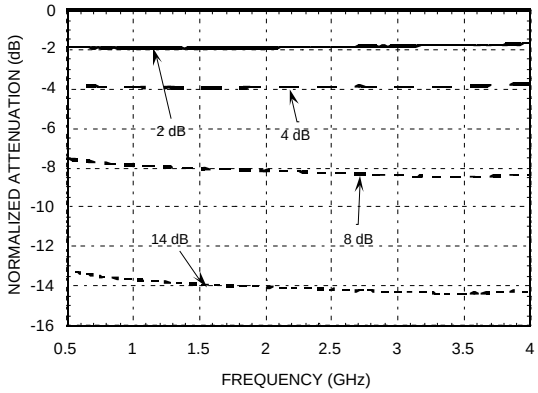
### Insertion Loss



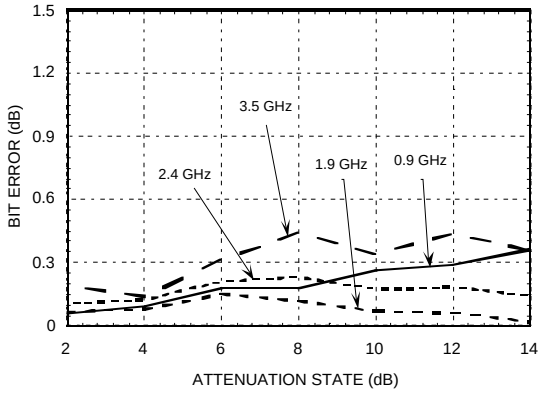

### Return Loss RF1, RF2
*(Only Major States are Shown)*



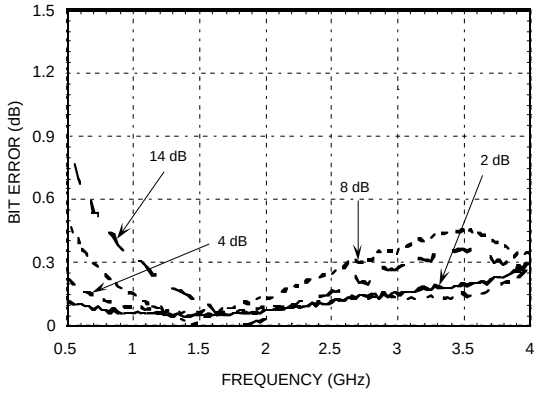

### Normalized Attenuation
*(Only Major States are Shown)*



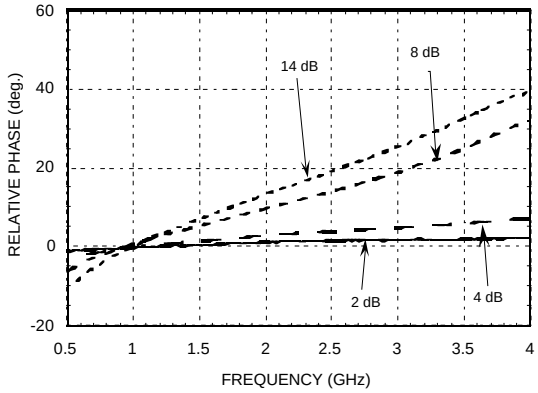

### Absolute Bit Error vs. Attenuation State




### Absolute Bit Error vs. Frequency
*(Only Major States are Shown)*




### Relative Phase vs. Frequency
*(Only Major States are Shown)*




*Note: All Data Typical Over Voltage (+3V to +5V) & Temperature (-40 to +85 deg. C.).*

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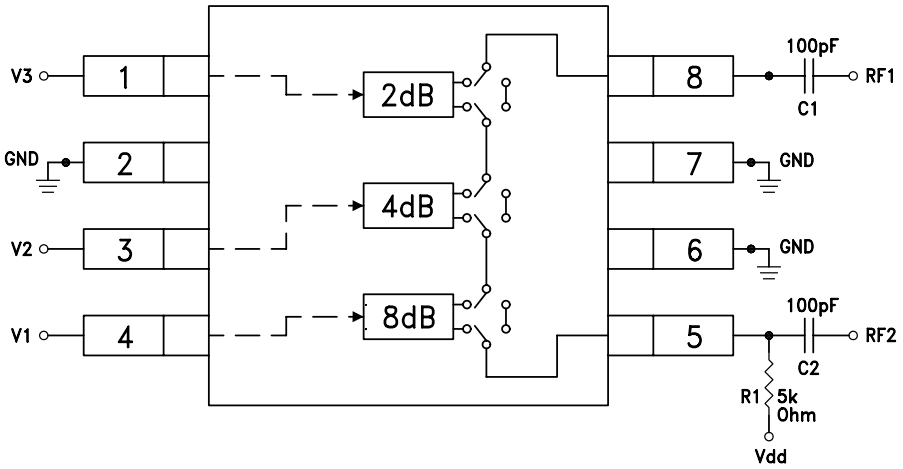
## Truth Table

| Control Voltage Input | | | Attenuation Setting RF1 - RF2 |
|---|---|---|---|
| V1 8 dB | V2 4 dB | V3 2 dB | |
| High | High | High | Reference I.L. |
| High | High | Low | 2 dB |
| High | Low | High | 4 dB |
| Low | High | High | 8 dB |
| Low | Low | Low | 14 dB Max. Atten. |
| Any combination of the above states will provide an attenuation approximately equal to the sum of the bits selected. | | | |

## Control & Bias Voltages

| State | Bias Condition |
|---|---|
| Low | 0 to +0.2V @ 20 uA Max. |
| High | Vdd ± 0.2V @ 50 uA Max |
| Note: Vdd = +3V to 5V ± 0.2V | |

## Application Circuit




DC blocking capacitors C1 & C2 are required on RF1 & RF2. Choose C1 = C2 = 100 ~ 300 pF to allow lowest customer specific frequency to pass with minimal loss. R1 = 5K Ohm is required to supply voltage to the circuit throught either PIN 5 or PIN 8.

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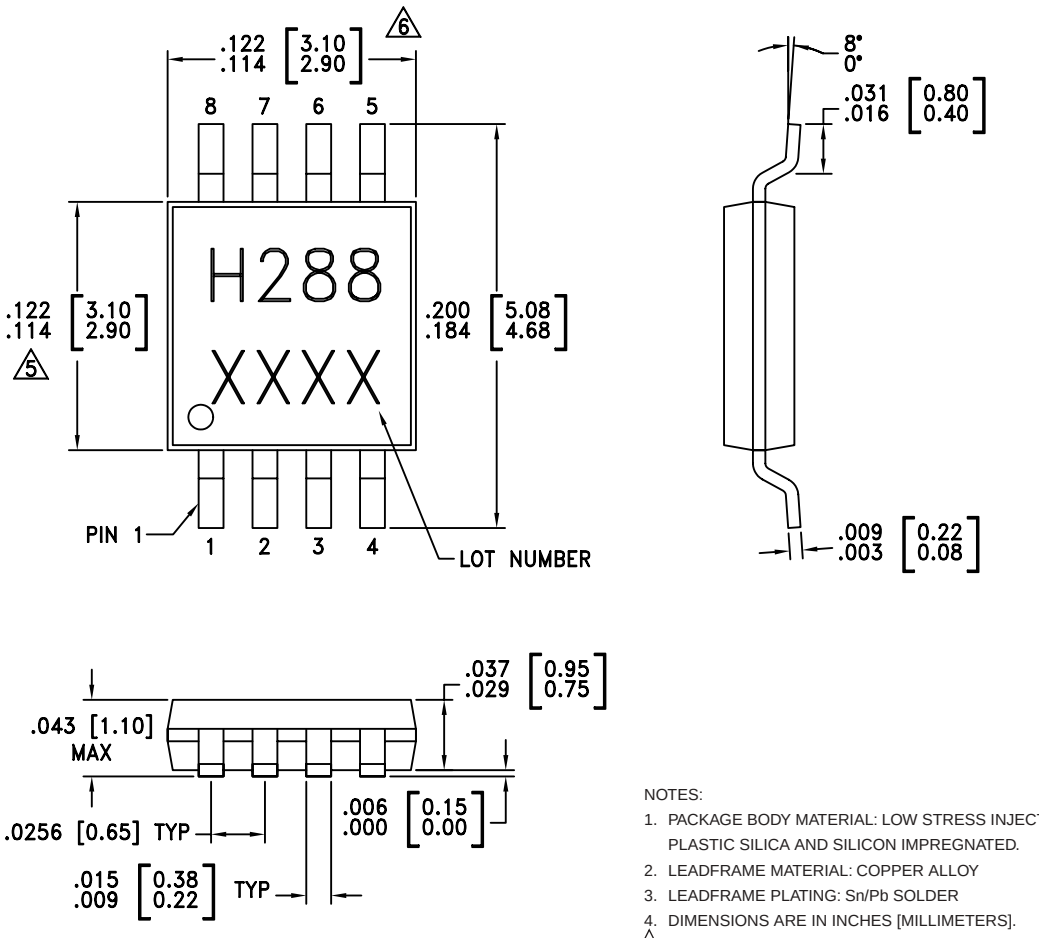
## Absolute Maximum Ratings

| | |
|---|---|
| Control Voltage (V1, V2, V3) | Vdd + 0.5 Vdc |
| Bias Voltage (Vdd) | +8.0 Vdc |
| Storage Temperature | -65 to +150 °C |
| Operating Temperature | -40 to +85 °C |
| RF Input Power (0.7 - 4 GHz) | +28 dBm |

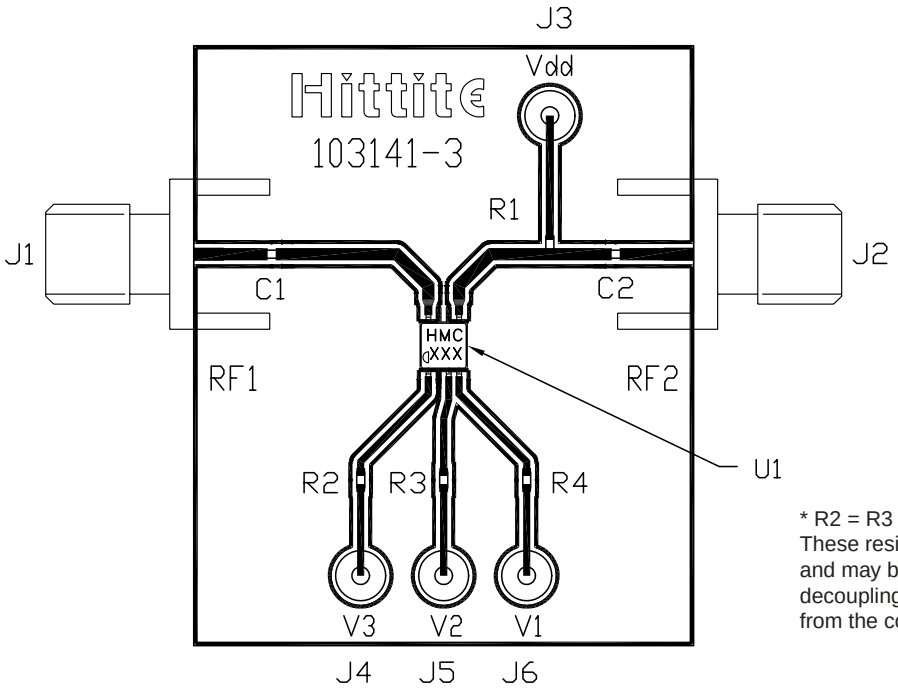
## Outline Drawing




NOTES:

1. PACKAGE BODY MATERIAL: LOW STRESS INJECTION MOLDED PLASTIC SILICA AND SILICON IMPREGNATED.
2. LEADFRAME MATERIAL: COPPER ALLOY
3. LEADFRAME PLATING: Sn/Pb SOLDER
4. DIMENSIONS ARE IN INCHES [MILLIMETERS].
5. DIMENSION DOES NOT INCLUDE MOLDFLASH OF 0.15mm PER SIDE.
6. DIMENSION DOES NOT INCLUDE MOLDFLASH OF 0.25mm PER SIDE.
7. ALL GROUND LEADS MUST BE SOLDERED TO PCB RF GROUND.

## Evaluation Circuit Board




* R2 = R3 = R4 = 100 Ohm. These resistors are optional and may be used to enhance decoupling of the RF path from the control inputs.

The circuit board used in the final application should use RF circuit design techniques. Signal lines should have 50 ohm impedance while the package ground leads should be connected directly to the ground plane similar to that shown . A sufficient number of VIA holes should be used to connect the top and bottom ground planes. The evaluation circuit board as shown is available from Hittite Microwave Corporation upon request.

## List of Material

| Item | Description |
|---|---|
| J1 - J2 | PC Mount SMA Connector |
| J3 - J6 | DC Pin |
| R1 | 5k Ohm Resistor, 0402 Chip |
| R2, R3, R4 | 100 Ohm Resistor, 0402 Chip |
| C1, C2 | 0402 Chip Capacitor, Select for Lowest Frequency of Operation |
| U1 | HMC288MS8 Digital Attenuator |
| PCB* | 103141 Evaluation PCB 1.5" x 1.5" |
| *Circuit Board Material: Rogers 4350 | |

**Notes:**